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THE EFFECT OF MATERIAL SHORTAGES ON PRODUCTION AT THE NAVAL AIR--ETC(U)

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THESIS

THE EFFECT OF MATERIAL SHORTAGES ON PRODUCTION AT THE NAVAL AIR REWORK FACILITY, ALAMEDA

by

Charles Wayne Grant

September 1979

Thesis Advisor: A. W. McMasters

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THE EFFECT OF MATERIAL SHORTAGES ON PRODUCTION

AT THE NAVAL AIR REWORK FACILITY, ALAMEDA

by

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Lieutenant, United States Navy
B.A., University of Richmond, 1970

Submitted in partial fulfillment of the
requirements for the degree of

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September 1979

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ABSTRACT

As a result of the Department of Defense Material Distribution Study, the Navy has begun to consolidate the wholesale inventories held at the Naval Air Station, Alameda and at the Navy Supply Center, Oakland. Due to this consolidation, the support responsibility for the Naval Air Rework Facility, Alameda, will shift from the Naval Air Station, Alameda to the Naval Supply Center, Oakland. This support involves the positioning of stock, the requisition processing and status function, and the movement of material through the system to the Air Rework Facility.

Planning for such support requires an examination of the industrial activity itself: the production processes involved, the policies and procedures that govern material movement, and material supply problems currently faced by production personnel. Research revealed that material shortages were a significant cause of production delays and inefficiencies. Material shortage induced delays also were found to have an impact on the material pipeline and on customer units. Finally, the level of material support provided to the Air Rework Facility is documented and recommendations as to changes to that service are offered.

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I. INTRODUCTION

A. BACKGROUND

On 1 October 1979, the Naval Supply Center, Oakland will assume cognizance of the wholesale inventory now held at the Naval Air Station, Alameda. This consolidation will involve the Supply Center in, among other things, the direct support of the Naval Air Rework Facility, Alameda, a task previously performed by the Air Station.

The Naval Air Rework Facility (NARF) is a major Navy industrial activity. Its major mission areas include depot level aircraft maintenance, major aircraft structural repair, component and ground support equipment maintenance, aircraft engine overhaul, and depot level missile maintenance.

B. THESIS OBJECTIVE

A major objective of the consolidation planning was to ensure that the level of service experienced by the activities in Alameda would not be in any way degraded by the consolidation.[1] This thesis research was performed to document the production characteristics of NARF Alameda, and to attempt to determine the level of service required to properly support that activity. More specifically, an attempt was made to determine the effect material shortages have on its production. If known, the detrimental impact of a material shortage could then be balanced against the costs of stock levels and transportation alternatives at NSC, Oakland as well as NARF, Alameda.

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[1] Naval Supply Center Oakland, Wholesale Supply Support Consolidation and Warehouse Modernization Plan, p. 3.

C. METHODOLOGY

The overall approach was to first document the type of industrial work performed by the NARF including scheduling, work flow, and problem areas. Second, material shortage problems were examined to show how this type of problem is handled by the production personnel and what the specific costs and other effects may be. Finally, possible changes in the local delivery response standards were proposed and examined.

In order to do this, three primary sources of data were relied upon:

1. Navy Directives and Instructions. The basis for a great deal of the daily operations are governed by instructions issued by a wide range of Navy commands. These instructions establish the policies and procedures which the operating units follow.

2. NARF, Alameda Reports and Records. The accounting records provide actual data as to the costs of production as well as performance measures.

3. Interviews. Since the policies and directives are subject to interpretation by those who implement them, interviews were held with production, production control, and material control personnel at different levels at NARF, Alameda and at NAS, Alameda.

In addition, during the research, it became evident that actual data was not available to adequately describe some aspeets of the problem. However, the opinion of the individuals concerned will hopefully provide some indication of the overall effect of material shortages.

II. RELATIONSHIP BETWEEN PRODUCTION AND MATERIAL SUPPLY

A. INTRODUCTION

Material supply is one of the key elements of any production process. A smooth and predictable supply source allows management to lay out facilities and schedule work in the most effective and efficient manner.

If the supply sources are not secure, the value of the plans and schedules are negated. In a sense, much of the economy of mass production are lost as each supply interruption requires individual solutions to production problems.

B. THE EFFECT OF A MATERIAL SHORTAGE

Material shortages affect industrial production in two primary areas: (1) production inefficiencies and delay, and (2) a reduction in output into the distribution channel.

1. Production Efficiency

Production inefficiencies and delays involve such things as work stoppages and work-arounds which can adversely impact direct labor costs. Lack of the proper material at the proper time forces rescheduling of production work and can result in increased indirect costs for material expediting, purchase monitoring, and faster transportation.

Material shortages affect NARF, Alameda in much the same manner as any industrial plant. Each major area, i.e., aircraft maintenance, component rework, and engine maintenance, has a slightly different organization and different needs. Each area, therefore, is affected in a slightly different manner by a shortage. Each area will be addressed separately in a later chapter.

2. Material Pipeline

The second effect of a material shortage is a reduction in the output into the distribution channel. This follows directly from the inefficiences and delays discussed above. If output is restricted, less material is available for sales to its customers.

The Navy distribution channel, or pipeline, consists of total system assets, including both ready for issue items (RFI) and not ready for issue (NRFI) items that are awaiting repairs. Given that an inventory manager is striving for a set rate of supply effectiveness, he can determine the number of RFI items required to support fleet assets. The RFI portion of the pipeline may therefore be considered to be fixed. Then it becomes obvious that the pipeline becomes longer as the total repair time increases. Delays, which increase total repair time, will directly affect the pipeline.

Material shortages affect the pipeline in several ways. As with any delay, a material shortage can cause a decrease in the production rate by increasing the total time that the item remains unserviceable and therefore unavailable for issue to customers. In order to maintain a given level of supply effectiveness, the inventory manager must maintain a higher level of system assets than would be necessary if no production delays existed. The pipeline costs are the investment costs and holding costs of the level of inventory.

An example of this is found in the component section. As noted in Exhibit (1) the dollar value of components in "G" condition, over 30 days in delay awaiting parts, at NAS Alameda as of June 1979 was nearly $30.0 million. This problem will be discussed in more detail in a later chapter, but it is clear that the total Navy investment in

unserviceable components is substantial. Exactly the same situation exists in the engine area. At NARF, Alameda over 100 engines are in delay while awaiting parts.

It may be that aircraft experience a similar pipeline effect. When evaluating the total number of aircraft needed to support a given level of operations, it is safe to assume that, at any point in time, a certain percentage of the aircraft will not be operationally available. Some will be experiencing a mechanical failure, others will be in maintenance, and others still will be in overhaul. For example, in order to have 90 aircraft combat ready at all times, it may be necessary to have 100 aircraft in the unit.

Under these circumstances for a given level of fleet readiness, a reduction in overhaul delays could result in a reduction of the total aircraft inventory. The savings could be significant. Each A-6E Intruder aircraft has a flyaway cost of about $10 million. Each F-14 Tomcat has a flyaway cost of more than $20 million. Further savings in reduced support requirements may also be possible.

Related to these increased pipeline costs are higher system costs to the customer. If an aircraft, for example, is not completed on schedule, the squadron that owns that aircraft remains without an operational asset until it is delivered. While there may not be direct cost for this delay, there are indirect costs associated with it. Likewise, in the case of engines and components, production delays could result in fleet aircraft remaining not operationally ready for the length of the delay. Missions may not be performed or may be marginally successful. Training may be postponed or cancelled. Total force readiness and mission capability may be seriously degraded.

C. RESEARCH AND LIMITATIONS

To examine the effects of operational delays or production, it would be most desirable to be able to examine production and financial records and identify the costs associated with each such delay. However, this type of charge is hard to capture, and is not, in fact, broken out by the existing accounting system at NARF. Discussions with the Comptroller's Office revealed that there was very little in the way of actuals available to document the production effect. Certain delay related costs are, however, recorded as part of the overhead charges.

In order to provide some degree of information, a more subjective approach was used. Interviews were held with key personnel in a wide variety of positions throughout NARF. These discussions represented the opinion of the individuals involved, and usually were not substantiated by hard data. However, it is hoped that these individual opinions will provide insight into the day-to-day operations on the production floor.

III. PRODUCTION AT NARF, ALAMEDA

A. INTRODUCTION

In this chapter each major phase of NARF, Alameda's activity will be described. It is important to understand the type of work being performed and the constraints under which the activity operates. Following this description, the levels of service required to properly support the activity will be considered.

B. AIRCRAFT DEPOT LEVEL MAINTENANCE

1. Description of Maintenance

NARF, Alameda is designated as a maintenance facility for the A-6, P-3, A-3, S-3, and C-118 series aircraft. During standard depot level maintenance (SDLM), each aircraft is inspected and all structural and equipment related repairs and inspections are conducted. In addition, the aircraft is normally updated to current standards by installing any outstanding airframe changes. Workload planning is accomplished two quarters in advance and is subject to revision at any time. However, there has not been a great deal of variability between the planned workload and the actual final tasking.

Each aircraft series has its own production flow during maintenance. For the P-3, C-118, and A-6 aircraft, a line is set up in one of two hangars and the aircraft physically move through the five or six stations, or spots, in the line. Each station is assigned specific tasks to do on each aircraft moving through.

The following table shows the major elements of the SDLM and the standard flowtime (in days) for two representative aircraft.

	P-3	A-6
Defuel/Evaluation	2	2
Clean/Strip	4	5
Disassembly	11	6
Structural and Electrical Rework	7	9
Structural and Mechanical Rework	7	9
Mechanical and Electrical Installation	7	9
System Test	7	3
Paint	5	5
Avionics Ground Check	4	3
Flight Test	2	1
Post Flight Test	1	1
TOTAL	57 days	53 days

As the aircraft proceeds through the hangar, it is stripped of all components scheduled to be repaired or replaced. Items which are repairable are sent out to the "feeder," or component repair. Although it varies widely between types of aircraft and individual aircraft themselves, approximately 400 components would fall into this category. However, another 900 to 1100 components are removed to provide working access to the airframe or its components in need of repair. These "removed for access only" components are stored until that aircraft is ready to be reassembled. During this time the reworked or new components are arriving for eventual installation in the aircraft.

The standard procedure is to, as far as possible, reinstall all components in the same aircraft from which they were removed.

2. <u>The Effect of a Material Shortage</u>

The aircraft line copes with material shortages through two forms of cannibalization: diversion, and backrobbing. Diversion is the reassigning of a ready for issue (RFI) part from one aircraft (or component or engine) to another. Components removed for access only and purchased parts are subject to diversion to any other aircraft that may require them. The aircraft lines use a computer controlled stacker to store and track these parts until they are needed.

The parts in the stacker, plus the approximately 400 parts which are being reworked in the feeder shops and the parts ordered through the supply system, provide a large pool of material which is available for diversion to other aircraft as needed. Since the parts are readily available "off the shelf", such diversion has little, if any, negative impact on production. The only extra work necessary is the administrative time needed to track the diversion so that, eventually, each aircraft receives the right parts. The computer that controls the stacker has been locally programmed to allow for easy diversion, linking, and tracking of parts.

The computer, however, does not keep summary statistics on how many diversions occur or on the particular parts being diverted. Informal discussions indicate that such diversions occur from "very frequently" to "all the time".

Backrobbing differs from diversion in that the parts required are currently installed on an aircraft and would not be removed except to satisfy the emergency requirement. There are, therefore, unique and

identifiable costs associated with removing the required part and returning a part to replace it. It represents work performed solely because the supply system could not provide material in time to prevent a work stoppage. Since these charges would not be appropriately charged to either the down aircraft or the supplier aircraft, the accounting system does provide for the accumulation of charges for backrobbing in an overhead account.

For example, if a completed aircraft is on the flight line for final predelivery testing, and it suffers a serious engine failure, it is very likely the NARF will backrob a replacement engine from an aircraft in process if an RFI engine is not available. It may require three men one shift to remove the replacement engine and that much more time to reinstall an engine in that aircraft. Those hours would not normally be charged to the aircraft job but they would appear in the indirect account entitled "backrobbing." This account makes up part of the overhead rate applied to all jobs.

It is not clear just how accurate these accumulated costs are. Certainly, the example just given is an extreme case. If the backrobbing action had required less time, perhaps 0.5 manhours, it is not likely that the mechanic would go through the administrative trouble of submitting a new job card for the backrobbing action. As a result, the backrobbing account will generally contain only charges for the "major" backrobbing situations. Charges recorded in this account over a one year period appear as exhibit (2).

In addition, the system does not provide information on how many backrobbing situations occur or exactly where they occur. The average length of the delay, or the average cost per delay is therefore

not available. It was the opinion of the production control personnel that most of the backrobbing situations involve relatively small charges and are not recorded anywhere.

In addition to the actual direct labor involved in a backrob, there are indirect effects. There is an effect on administrative effort to track the backrob and to plan and arrange for eventual replacement. Production schedules for both aircraft (the one with the material shortage and the one which supplied the replacement part) may have to be adjusted. Backrobbing can also result in the breakage of parts or components during the exchange and perhaps even double consumption of materials when items are not properly tracked or when breakage does occur.

In summary, material shortages have a definite effect on the aircraft production effort. The flow pattern and the relative ease of diversion and backrobbing appear to minimize the overall effect on schedules. The P-3 SDLM line, for example, has a flow time of 57 days. In the first quarter of FY79, the average actual turn-around-time was 58 days.

C. THE COMPONENT REWORK LINE

1. Introduction

The Component Line (the "F/E" line) is affected in a slightly different manner by a material shortage. Much of the differences stem from the type of work actually performed. The component workload tasking occurs two quarters in advance. However, unlike the aircraft maintenance line, the actual tasking varies widely due to changes in demand.

Weekly probes designate high priority work which override existing plans. Further, these shops are the same shops that rework components for the aircraft and engine lines.

It is difficult to describe a "typical component" at NARF, Alameda. A wide range of components are included. Electronic items, hydraulics, and structural fabrication all fall into this category. For the purposes of this discussion, an electronic component will be used as an example. Most of the comments would apply to other types of components as well.

2. Description of Component Rework

The work flow for components is different from that described earlier in the aircraft section. Most component rework does not flow in a production line, but rather is a "workbench" arrangement. All of the repair is accomplished by one individual and the component remains at one location throughout the repair.

When a component is inducted, it is sent to the cognizant shop, where a technician examines the component, determines the malfunction, and orders the necessary materials for the repair. He then places the component on the shelf until the parts come in. At that time, the component is taken down from the shelf, re-examined and repaired. The component is then tested, calibrated and sent from the shop on to its destination.

The variability of the workload does complicate the task. Some components are repaired constantly throughout the year. Others may involve the repair of three units one quarter and then go for several quarters before any others show up for repair.

Another special characteristic of component repair, particularly electronic items, is that many repairs are sequential in nature. For instance, initial testing may indicate that a particular circuit board has failed. However, without that board, it is impossible to check out other sections of the component. When the defective board is replaced, other problems are discovered. This situation may require several "sets" of requisitions and results in very long production times.

3. Effects of A Material Shortage

Cannibalization is common among components that experience regular induction into NARF, Alameda. For example, there may be twenty of a particular CLAMP (Closed Loop Aeronautical Material Program) item undergoing repair at any one time. The technician will, in all likelihood, do anything possible to meet his production requirement or get as close to it as is humanly possible.

No documentation is available to indicate how widespread the practice may be. Exhibit (2) provides what backrobbing charges are recorded in this area. Discussions with personnel in one shop indicate that in CLAMP components, more components are cannibalized than are not.

Another problem is that, in general, each repair is different. Certainly, some types of repairs frequently recur, however, each component requires a different action. When the technician first receives a component, it is tested and then set aside awaiting parts. By the time the parts come in, the worker may have looked at dozens of the same item. Although the test results and a description of the problem are documented by the technician, it is hard to remember the exact circumstances associated with each particular component. There is some loss of learning in this situation.

Finally, when the supply system status on requisition material indicates that 100 percent of the required material will not be available within thirty days, the component will be slated for "G" condition. NAS Alameda maintains physical and financial custody of material in "G" condition. When the component is designated to be in "G" condition, the parts on order are normally cancelled, and will be reordered by NAS, using a NAS requisition number and citing special accounting class 203 funds are required by ASO Instruction 4230.1. When all of the parts are available, the component is reinducted. Exhibit (1) provides data as to the size and changes in the "G" condition picture at NAS.

Transfer to "G" condition requires packaging and preservation and some transportation expense. Each individual component must be tracked through "G" condition as well which is a significant administrative task. Reinduction into the NARF after all of the bit and piece parts are available also depends on the NARF capability and desire to work on that component at that particular time. The shops may be at full capacity with high priority work, and if there is not any immediate demand for the reinducted component, the NARF would not be anxious to spend manhours on a component destined for stock.

A final consideration is that the components under repair may be needed to support the aircraft or engine lines. Delays in component repair, then, can impact schedules in other areas within NARF.

D. ENGINE LINE

1. Introduction

Under the Engine Analytical Maintenance Program (EAMP), engines are no longer automatically completely overhauled, but rather each

maintenance action is designed to repair the particular failure which occurred in that engine. Thus, each repair is slightly different.

Engine maintenance problems begin with the induction schedule. As with the other programs, the workload planning occurs two quarters in advance. However, while the quarterly workload is seen to be fairly accurate, the weekly workload varies widely. For example, the work to be performed during any given week depends on the engines arriving at the NARF at the proper time. Generally, the NARF operates without a backlog of NRFI engines on most programs. On the particular Friday afternoon this author visited the engine facility, the production personnel were unsure exactly what engines would be inducted the following Monday. The daily induction schedule specified which engine model and series was expected in for repair, however, the actual engines had not arrived at the NARF. The planners then examined those engines which were available and in need of repair as well as the shop manhour loading situation and inducted enough work to keep the shops active on productive work. The planners indicated that, for some engines, this situation is a regular occurrence.

2. Description of the Maintenance

Once an engine is inducted, it is disassembled and the parts are sent to the appropriate shops for cleaning, inspection, and repair. New parts are requisitioned as necessary. After cleaning and repair in the feeder shops, the components collect in a central stacker until the production schedule calls for final assembly. The components are then returned to the shop and the engine reassembled and tested. Each engine is run up in a test cell to insure that it is functioning properly.

Any problem, whether or not connected to the work performed by the shop, is investigated and repaired.

3. <u>Effects of a Material Shortage</u>

The engine programs have been experiencing continuing material support problems. During the first quarter of FY 79 material support problems were blamed for much of the labor hour variances incurred on the J-52 and T-56 engine programs. The variance amounted to 3131 hours on a base of 72,331 hours (4.3 percent). Further discussions revealed that the most serious material problems were of a long term nature and were well documented. One example presented concerned the T56, series 3, engine used in the P-3 and E-2 aircraft. One particular component, the power unit turbine inlet case (2RH 2840-00-225-0953 DQ), had been available in January 1977 with a leadtime of about one month. In February 1978, the leadtime stretched to about 12 months and currently is about 15 months. As of August 1979, when 55 T56 engines were in process, 26 were in a delay status due to the nonavailability of this part.

This situation is only one of many similar examples that could be presented. Material availability rather than material response times is the major cause of material problems on the engine line.

Another characteristic of these engines is that parts usage can be cyclical. As a particular engine model gets older, a component which had had a very low failure rate over the years, may begin to fail in nearly every engine. This puts a severe strain on the supply system to keep up with the demand and can result in a procurement with months of leadtime involved before delivery. Large fluctuations in demand

will cause shortages until the manufacturer's production and the supply system can catch up.

As in the aircraft program, diversion and backrobbing are very common, but no data is available to describe exactly such activity. Exhibit (2) details the backrobbing charges which were recorded. The mechanized stacker provides a ready pool of spares, however, the administrative problems associated with cannibalization are more significant than in the aircraft program since the engine stacker is a manual system. (The stacker is operated by several attendants that assign storage locations and maintain handwritten records of the stacker's contents and locations.)

But cannibalization has an additional negative impact which is peculiar to the engine program. The standard procedure is to keep all of the parts of an engine together as much as possible. A jet engine is a delicate equipment built to close tolerances, however, over time components tend to "wear together". A used component, still within tolerances, may not work properly in another engine because the parts are worn in a different manner. Theoretically, if cannibalization increases, greater problems should be expected during testing.

A key decision point in the engine maintenance cycle occurs at the point of final assembly. If, at that time, all of the components are not available, the engine is transferred to "Code 94". This is an administrative classification that involves little actual expense, except that all work ceases on the engine until all of the parts required are received. The parts could be coming from supply or from one of the feeder shops.

The engine parts do not leave the building but may require minor preservation. As was the case for components in "G" condition, the time that an engine is in "Code 94" does not count as a penalty against the NARF. That is, the turn-around-time (TAT) statistics do not include the amount of time that an engine is held in "Code 94". (TAT) does not accumulate. During the first quarter of FY 79, the average TAT was 33 days, while the average time an engine was at the NARF was 91 days. The number of engines in "Code 94" in June 1979 was 102.

IV. LEVELS OF SERVICE

A. INTRODUCTION

Thus far, the types of work performed by NARF, Alameda have been explained as well as the actions taken by the various divisions to cope with the problem of material shortages.

Actually, material shortages can occur for three reasons. First, material which is available locally may not be delivered quickly causing days of delay in production areas. Second, the material may not be available locally even though it is available within the Navy's supply system. This type of shortage causes delays as the material is shipped to the NARF. Finally, the material may not be available in the system at all. This requires a procurement action (with its leadtime) a manufacturer's production run (with its leadtime) and shipping (at its time).

B. MATERIAL AVAILABILITY

The question of material availability is one of stocking policies and procedures. Evaluating possible alternatives to the current system is beyond the scope of this research. However, the level of material availability currently provided to the NARF by NAS was determined.

Exhibits (3) and (4) summarize the point of entry (POE) effectiveness provided by NAS to the NARF for a three month period ending 31 March 1979. It shows that, for the material cognizance codes presented, NARF, Alameda received only slightly more than 40 percent of all the material it requisitions from NAS Supply.

To put this into perspective, consider the repair of a particular component which requires four different parts. If it can be assumed that the fact that NAS Supply has a particular part is independent of it having any other part, then the probability of having all four parts is the product of each separate probability. In this case, since the overall effectiveness is .408, the probability of the NARF obtaining all four parts from NAS is $(.408)^4$ or .0277. Even if effectiveness is raised to a .85 level, the probability of having all four parts is $(.85)^4$ or .522. Of course, this includes only assets available immediately off the shelf at NAS and does not include stocks held at NSC, Oakland or any other activity. But it does highlight the seriousness of material availability and its importance to the overall industrial effort.

C. CURRENT STANDARDS

Requisition and delivery response standards within the Department of Defense are governed by the Uniform Material Movement and Issue Priority System (UMMIPS) as set forth in OPNAV Instruction 4614.1 (series). The UMMIPS standards, for example, prescribe how fast NSC Oakland should respond to requisitions of various priorities. The last column of the table shown below lists these standards.

NAS, Alameda and NARF, Alameda currently have an agreement which commits NAS to respond to NARF requisitions much faster than the UMMIPS requirements. The third column of the following table provides these standards.

Issue Group	Priority	NAS Standard	NSC Standard (UMMIPS)
I	01-03	2 hours	2 days
II	04-08	4 hours	3 days
III	09-15	24 hours	11 days

The NAS standards are a result of a mid-1960 agreement between NAS Supply and the NARF. At that time, the two activities were two departments within the Air Station. The Supply Department maintained approximately 26 individual storerooms which were co-located with the shops in the depot. In an effort to reduce duplication and waste, supply consolidated the stock in a central location but promised the above delivery schedule to insure that service to the shops was not degraded.

At this point, it will be helpful to examine the level of service actually received by the NARF from both NSC, Oakland and NAS, Alameda. To do this, requisition data extracted from the Demand History File was used to track requisition processing time and delivery time. The results of this analysis appear below:

NAS ALAMEDA

Issue Group	Total System Response Time	Supply Point Response Time
I	5.0 days	0.2 days
II	5.8	0.4
III	3.1	1.2

NSC OAKLAND

Issue Group	Total System Response Time	Supply Point Response Time
I	8.2 days	1.0 days
II	9.6	1.9
III	12.1	5.6

A detailed report of this analysis appears as Exhibit (5).

What this review indicates is that NAS does not appear to be meeting the standards established for NARF support. The NAS does respond faster than NSC Oakland, however. Of even greater interest are the total requisition times which indicate that NARF, Alameda is experiencing very long overall times, and that most of the delay is internal to the NARF itself. On Priority 02 items, for example, NAS made the issue and delivered the material to the customer in an average of 0.2 days once NAS received the requisition. However, it took the NARF an average of 3.6 days to process and release the requisition into the system. It appears that major improvements in overall material response times may be possible simply by improving procedures within NARF, Alameda.

D. THE EFFECTS OF CHANGES TO RESPONSE STANDARDS

The evaluation of the existing standards and of possible changes to those standards was based on interviews and informal discussions with NARF production and production control, and material planners. Although highly subjective, these opinions offer insight into the actual production operations.

1. Aircraft Line

The aircraft line personnel, who have more flexibility to overcome material shortage problems were least impressed by suggestions of possible improvement to deliveries of two to three hours for IG II material. The planners this author talked to stated that the time standard itself was not of great importance. It was much more critical that whatever standard is established is met consistently. Overall, material availability is much more critical than rapid response.

It was also believed that, since work-arounds and cannibalization were readily available, the length of the production work on the aircraft would not be different, that is, the turn-around-time for the scheduled flow would not change.

While delivery time measured in hours is not critical for the aircraft line, in general, the Flight Line might benefit from delivery times of one or two hours. If an aircraft being tested just prior to delivery to fleet develops a problem, it would be valuable to obtain repair parts as quickly as possible. The parts may or may not be related to the work performed by the NARF but may be for any repair necessary for air-worthiness which must be made so that the aircraft can be tested. There is no more "slack" in the schedule and any delay directly affects completion. It is not clear how often this problem occurs, but when it does, the parts required are now available through diversion, back-robbing, or NAS supply. Which source of supply is used depends on the specific part required and the schedule of the aircraft. It appears as if diversion is the preferred action and that a decision between back-robbing or NAS supply is based on either requisition status or the experience of the personnel involved as to best method of filling the requirement.

It is likely that the demands would be highly random and that the range of items demanded is broad.

2. <u>Component Line</u>

Suggestion of response times of two or three hours for IG I and II brought mixed responses in the component area. The primary point raised was that unless the supply effectiveness was 100 percent, such time standard would be meaningless. The technicians were quick to state that it would not accomplish anything to have 85 percent of the parts available in two hours, and then have to wait for three weeks for the remaining 15 percent.

It was noted, however, that since some of the repairs are sequential in nature, a quick response to unforeseen secondary requirements would be of great value. Even if the bulk of parts were available in three weeks, the technician, when he assembled the unit, may discover that he needs one more item to finish the job. A quick response on that final item could allow timely completion of the unit and avoid another three week delay.

The production control center was concerned about "G" condition material. It was believed that more logical and timely decisions could be made about committing items to "G" condition if adequate information was available early concerning requisition status and material availability. Currently, the production control centers prepare the requisitions and send them to the material control centers where the requisition data is checked, verified, and keypunched for transmission to NAS Supply. The production control center does not know whether specific parts are currently available from the NIF stores or NAS or NSC. Requisition

status is considered to be unreliable and slow. It was considered normal not to receive status on a requisition for 10 to 12 days after submission.

3. Engine Maintenance

The response to proposed delivery times of two or three hours was mixed in the engine area as well. This was probably due to the fact that the biggest problems faced were that the engine division are ones of material availability rather than response times.

Of the short time problems, one area of concern was information about material availability. The shop personnel needed to know what material was available and at what locations so that a logical cannibalization decision could be made. As in the component areas, the production control center and the production supervisor do not know if a particular part is available in NIF stores, at NAS, or at NSC. Armed with the right information, proper decisions about cannibalization could be reached.

One question posed to a production supervisor was "Given the situation that you could have a new part available in three hours, would you wait for a part from supply or divert the part from another engine?" The immediate response was to divert the part. The reasoning was that:

a. production was in control of a diversion and therefore the extent of the delay was within his sphere of control,

b. he was skeptical that supply could deliver and that he was unable to find out in advance that immediate delivery was possible, and

c. completing the engine was his primary objective.

Although this was only one individual opinion, it appears that more than

a fast response time from NSC Oakland will be necessary to gain efficiency in this area. Customer confidence and ability to impact the system will be important factors.

As in the components, it was stressed that 100 percent supply effectiveness is required before work can be completed. Rapid response on 85 percent of the parts requisitioned will not yield marked changes in NARF production or in the number of engines in a delay status.

V. CONCLUSIONS

This thesis has attempted to determine the effects of a material shortage on production of an industrial activity. A brief overview of the business base for NARF, Alameda was presented as background and various approaches used by the different divisions to cope with material shortages have been explained.

NARF, Alameda suffers from material shortages in much the same manner as any commercial industrial plant. There are work stoppages, work-arounds, worker inefficiency, and administrative problems such as rescheduling and planning. All of the above items adversely affect efficiency and therefore the cost of doing business.

The Navy, as a whole, suffers from delays in production. Customer units may experience degraded service such as grounded aircraft and impaired mission capability. More material in delay requires more material in the pipeline to prevent service degradation.

The production divisions cope with these problems largely by diverting RFI parts from one inventory to another. The other method is to backrob a part from a unit which is not operational to allow another unit to become so.

These two actions will sustain production temporarily, but they have costs associated with them. Cannibalization increases the risk of damaging good material and it increases the administrative workload by requiring tracking and rescheduling.

Examination of the processes and discussion with the people involved leads this author to the following conclusions:

(1) The cost accounting system currently does not capture the cost, duration, or nature of a material shortage delay in any program.

(2) The type of production currently underway at NARF, Alameda does not require delivery times of less than 12 hours. Standards that guarantee two or four hour delivery are, at this point, not necessary. Neither the production efficiency nor the material pipeline would change significantly if such a standard were met.

Improvements to the existing system should address, as a minimum, the following points:

(1) Material Availability. The material shortage problems that appear to have the greatest effect are ones of material availability rather than slow local delivery.

(2) Information. NARF personnel making production decisions need accurate and complete material availability information in order to make intelligent production decisions.

(3) Actual Performance. Overnight delivery appears to be sufficient for normal situations. This standard should measure the time from the point at which the material requirement is identified by production control personnel until the material is physically at the production control center and ready for use. It is important that the standard be met. The people using the system must have confidence that it will work. NSC, Oakland and NARF, Alameda should continue to work together to reduce the total system response time by reducing requisition processing delay and duplication.

G Condition Material Status

	April	May	June
G Condition Components			
Number of Line Items	793	867	905
Number of Components	4693	4448	4617
Number Awaiting Reinduction	210	139	107
Bit Piece Requirements			
Due In	4608	4809	5998
On Hand	4998	4731	4844
Total	9606	9540	10842
Dollar Value of G Condition Material ($ millions)			
Components	27.0	28.6	29.8
Bit Piece Parts	1.4	1.7	1.3

Exhibit (1)

NAVAL AIR REWORK FACILITY, ALAMEDA

BACKROBBING CHARGES

(Indirect - Account "MB")

Code	Charges (hours) 6/30/78	9/30/78	12/31/78	3/31/79	TOTAL
520	831	457	321	24	1633
650	43	0	8	40	91
660	0	0	0	7	7
930	1203	1088	542	948	3781
940	453	201	828	2966	4448
950	8133	9233	6888	8083	32337
960	781	596	462	819	2658
					44955

Note: At the standard labor rate of $13.05 per hour, 44,955 hours equals $586,663.

Exhibit (2)

NAS ALAMEDA SUPPLY POE EFFECTIVENESS

FOR

NARF ALAMEDA

(JAN 79 - MAR 79)

COG	JAN	FEB	MAR	TOTAL
9A	40.0	36.8	20.0	31.8
9C	34.3	35.4	34.2	34.6
9D	58.1	76.3	40.0	56.3
9E	50.0	14.3	42.9	35.0
9F	26.1	18.5	32.3	24.9
9G	47.7	40.9	44.7	44.4
9H	40.0	20.0	40.0	33.3
9I	2.3	6.3	8.7	6.3
9J	30.5	26.4	30.3	28.8
9K	10.9	3.6	0.0	5.0
9N	35.6	37.0	35.2	35.9
9O	11.8	0.0	0.0	6.3
9Q	54.3	47.9	49.9	50.2
9S	0.0	0.0	0.0	0.0
9V	42.4	45.3	34.3	40.5
9W	28.0	25.4	34.6	29.9
9Y	34.6	34.2	58.8	42.9
9Z	45.2	42.8	43.7	43.8
1H	50.0	59.9	55.2	55.7
1R	52.4	59.5	53.5	53.2

"BIG FIVE" SSD COGS (9C, 9D, 9G, 9N AND 9Z) 40.8

Exhibit (3)

NAS ALAMEDA POE DEMANDS

FROM

NARF ALAMEDA

(JAN 79 - MAR 79)

COG	JAN	FEB	MAR	TOTAL
9A	10	19	15	44
9C	915	975	1066	2956
9D	31	38	50	119
9E	6	7	7	20
9F	92	157	124	373
9G	837	867	1098	2802
9H	5	5	5	15
9I	44	63	69	176
9J	325	432	356	1113
9K	46	28	46	120
9N	2261	2256	2846	7363
9O	17	5	10	32
9Q	645	974	984	2603
9S	5	1	--	6
9V	628	894	864	2386
9W	50	59	78	187
9Y	26	38	34	98
9Z	4374	5065	5244	14683
1H	98	157	183	438
1R	2489	2984	3580	9053
2R	173	271	309	753
5R	214	140	58	412
6R	11	6	5	22
8R	3	12	48	63
TOTAL				45837

Exhibit (4)

	NAS, ALAMEDA (5/78 - 10/78)				NSC OAKLAND (9/77 - 8/78)			
PRIORITY	REQNS	NARF ADMIN	NAS PROCESSING	TOTAL SYSTEM	REQNS	NARF ADMIN	NSC PROCESSING	TOTAL SYSTEM
01	0	-	-	-	0	-	-	-
02	1619	3.6	0.2	3.8	850	5.6	1.0	6.6
03	13,331	5.1	0.2	5.2	8083	7.4	1.0	8.4
04	3	2.0	1.0	3.0	2	9.0	0.5	9.5
05	63	1.6	0.3	2.0	93	5.9	2.0	7.9
06	28,985	5.4	0.4	5.8	12,534	7.7	1.9	9.6
07	12	1.5	0.7	2.2	22	4.3	1.6	5.9
08	3	21.7	-	21.7	4	5.8	3.0	8.8
09	1439	1.2	1.5	2.7	652	6.3	5.2	11.5
10	0	-	-	-	0	-	-	-
11	0	-	-	-	0	-	-	-
12	3	2.7	-	2.7	9	9.7	5.8	15.5
13	7577	2.1	1.4	3.5	2409	6.3	5.2	11.5
14	4	-	1.0	1.0	2	5.5	4.5	10.0
15	2897	3.1	1.4	4.4	791	6.8	7.4	14.2

Exhibit (5)

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